stations are received during the hurricane season, and advices regarding disturbances are prepared for transmittal to the various islands of the West Indies. The observational data thus collected are promptly telegraphed to the Central Office of the Weather Bureau at Washington, D. C., together with warnings or advices that may have been issued.

The West Indian observation stations, which are regularly equipped and officered by the Weather Bureau, number thirteen, and provision has been made for ordering and displaying, through these stations, hurricane warnings at more than one hundred points in the West Indies. The distribution of hurricane information and advices throughout the West Indies is limited only by the telegraphic and messenger services possessed by the several islands.

During the summer of 1899 reports by telegraph were begun from well-distributed Mexican stations. These reports are furnished through the cooperation and courtesy of the Director General of the federal telegraph lines of Mexico, who delivers them (free of expense to the United States) to the official in charge of the Weather Bureau office at Galveston, Tex., who, in turn, promptly transmits them by telegraph to Washington. Credit for arranging the plan of exchange of meteorological reports between the United States and Mexico is in a large measure due to Dr. I. M. Cline, official in charge of the Weather Bureau office at Galveston.

The Central Office of the Weather Bureau at Washington now has for its consideration reports from an area which extends from the South American coast to northern Canada, a region whose extreme limits cover latitude 11° to 53° north, and longitude 60° to 125° west, or more than 42° of latitude and 65° of longitude.

The advantage afforded by this great area of telegraphic observations can scarcely be estimated. By means of the West Indian reports the tropical storms which cross the more eastern islands of that group can be detected almost in their inception. They can be traced day by day, and the probable time of their arrival at any point in their line of advance can be forecast.

By means of the Mexican Gulf coast reports the development of storms near the Yucatan and Mexican coasts can be detected, and the course of West Indian storms which cross the Gulf of Mexico can be determined. These reports furnish information which render possible warnings of the severe cold waves and northerly gales which visit the Gulf districts of Mexico during the winter months. It is believed that the reports received from northern and western parts of Mexico will lead to a better understanding of the important storms which sweep northeastward from the tropical Pacific over northern Mexico and cross the United States from the Rio Grande and southern Rocky Mountain districts to the Atlantic.

Reports from the extreme British Northwest Territory, which have been added within the last two years, have furnished valuable data regarding the movements of north Pacific storms, and will contribute to present knowledge of the mechanism of the severe cold waves which appear in that region.

The extensions referred to constitute one of the most substantial advances in the history of the Weather Bureau. The telegraphed reports afford daily and twice daily meteorological surveys of the populated parts of North America and a great part of Central America and adjacent waters, by means of which weather changes and conditions calculated to benefit or injure maritime or commercial interests can be forseen. And it is believed that each extension of the area of observation brings nearer that desideratum of meteorologists—long range forecasts. When this area shall have been extended to even partly include the great oceanic permanent cyclones and anticyclones the science of meteorology will advance from a knowledge of effects to a more perfect understanding of one of the causes thereof.

OBSERVATIONS AT HONOLULU.

Through the kind cooperation of Mr. Curtis J. Lyons, Meteorologist to the Government Survey, the monthly report of meteorological conditions at Honolulu is now made partly in accordance with the new form, No. 1040, and the arrangement of the columns, therefore, differs from those previously published.

Meteorological observations at Honolulu, June, 1900.

The station is at 21° 18′ N., 157° 50′ W.

Hawaiian standard time is $10^h\ 30^m$ slow of Greenwich time. Honolulu local mean time is $10^h\ 31^m$ slow of Greenwich.

Pressure is corrected for temperature and reduced to sea level, and the gravity correction, —0.06, has been applied.

The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force or amounts of cloudiness, connected by a dash, indicate change from one to the other.

The rainfall for twenty-four hours has always been measured at 9 a. m. local or 7:31 p. m. (not 1 p. m.), Greenwich time, on the respective dates.

The rain gage, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 43 feet, and the barometer 50 feet above sea level.

Date.	Pressure at sea level.	Temperature.		During twenty-four hours preceding 1 p. m. Greenwich time, or 2:30 a. m., Honolulu time.									Total rainfall at 9 a. m., local time.
				Temperature.		Means.		Wind.		Average cloudiness.	Sea-level pressures.		
		Dry bulb.	Wet bulb.	Maximum.	Minimum.	Dew-point.	Relative humidity.	Prevailing direction.	Force.		Maximum.	Minimum.	
	*	†	†			‡	‡		§				
1	29.96	73	68.5	83	74	64.5	67	ne.	3	3	30.01	29.95	0.05
2	29.97	73	67.5	82	72	66.0	71	ne.	4	3	30.00	29.94	0.03
3	29.97	69	67.5	83	72	65.0	67	ne.	4-1	5	30.03	29.94	0.08
4	30.00	67	64	83	68	65.3	72	ene.	1-5	5-2	30.03	29.95	0.00
5	29.99	68	66	83	67	64.7	70	ne.	3	3	30.05	29.96	0.00
6	30.00	74	69	85	67	67.7	78	sw-n.	2-4	1-4	30.04	29.97	0.00
7	29.99	74	67.5	85	72	66.3	66	ne.	3	1	30.04	29.96	0.00
8	30.00	75	69	85	69	64.5	65	ne-nne.	3	1	30.04	29.95	0.00
9	30.03	72	67	85	73	64.7	63	ne.	3	2-5	30.06	30.00	0.00
10	29.97	67	64.5	84	72	64.0	66	ne.	4-1	3-1	30.05	29.96	0.00
11	29.94	71	67	85	67	62.3	65	nne.	3-0	1-0	30.01	29.94	0.00
12	29.91	71	69	86	69	67.0	72	ne.	2-0	4	29.97	29.88	0.05
13	29.87	74	70.5	82	70	68.0	78	ne.	3	5	29.92	29.86	0.00
14	29.92	75	69	85	72	67.7	71	ene.	3	5	29.94	29.86	0.00
15	29.94	76	68.5	86	74	65.5	64	nne.	3-4	1-4	29.98	29.90	0.00
16	29.98	75	68.5	85	75	66.0	65	ne.	4	2-5	30.01	29.96	0.06
17	29.98	77	70.5	85	74	65.5	64	ene.	4	3	30.01	29.96	0.01
18	30.00	76	69	86	76	67.0	65	ne.	3	3	30.02	29.95	0.01
19	30.03	72	67	86	73	63.7	60	nne.	3	1-0	30.06	29.98	0.00
20	30.03	75	68	86	70	63.5	62	ne.	3	3-1	30.08	30.02	0.00
21	30.05	76	68.5	85	70	64.3	62	ne.	3	3	30.07	30.00	0.00
22	30.02	75	69.5	86	75	65.5	63	ne.	3	3-6	30.09	29.99	0.00
23	30.01	75	72.5	88	75	67.3	66	ne.	2	1-4	30.07	29.99	0.04
24	30.02	77	69.5	84	75	70.3	78	ne.	2	5	30.07	30.00	0.00
25	30.02	74	70	86	75	65.7	64	ne.	2	1	30.07	29.99	0.04
26	29.99	76	68	85	73	68.0	73	nne.	1-3-0	3-1-7	30.05	29.98	0.03
27	29.98	75	70.5	85	72	65.7	67	ne.	2-5	3	30.04	29.98	0.40
28	29.97	76	70	82	72	68.3	76	ne.	2-4	7-3	30.02	29.96	0.05
29	29.97	77	70	84	75	68.0	73	ne.	4	3	30.01	29.94	0.01
30	29.99	77	70	85	77	67.0	65	ne.	3.5	3	30.03	29.96	0.02
Sums.	......	......	......	......	......	......	......	......	......	......	......	......	0.88
Means.	29.983	73.7	68.3	84.7	72.2	66.0	68.0	......	3.0	3.1	30.029	29.956	......
Departure.	—0.02	......	......	......	......	+0.5	—2.6	......	......	—0.9	......	......	—0.72

Mean temperature for June, 1900 (6+2+9) ÷ 3=77.6°; normal is 75.9°. Mean pressure for June (9+3) ÷ 2 is 29.991; normal is 30.012.

*This pressure is as recorded at 1 p. m., Greenwich time. †These temperatures are observed at 6 a. m., local, or 4:31 p. m., Greenwich time. ‡These values are the means of (6+9+2+9) ÷ 4. §Beaufort scale.

RAINFALL AND DRAINAGE IN THE UPPER CHAGRES RIVER.

By Gen. HENRY L. ABBOT, dated July 10, 1900.

During the past year the matter of rainfall and drainage on the Isthmus of Panama has received special study. The following results are translated from my original paper compiled for the Compagnie Nouvelle and are communicated to the MONTHLY WEATHER REVIEW as being of general interest.

There are some small differences between the inclosed figures and those formerly sent, caused by errors in the report of rainfall first received from the Isthmus, but fortunately they are of no importance.

The Valley of the Chagres above Bohio may be divided into three subbasins, of which the general dimensions are given in the following table. The figures for the upper basin are only approximate, as toward the southern side the divide has not been accurately defined by surveys; but no material error is believed to exist. The two lower basins are well determined.

The upper basin includes the most mountainous district. About 7 miles above Alhajuela the principal stream takes the name of Pequini, and heads within about a dozen miles of the Atlantic coast, where the rainfall is greatest. It is from this region that the river receives its chief contributions, especially during the dry season; but during the eight months of rains the lower tributaries considerably increase the volume.

Geographical details of the basin of the Chagres.

Subbasins.	Area.		Length.	Width.	Length of channel.	Number of tributaries (about).
	Square miles.	Per cent.				
			Miles.	*Miles.*	*Miles.*	
Bohio-Camboa	250	37	11	23	19.5	17
Gamboa-Alhuela	130	19	7	18	11.0	15
Above Alhuela	290	44	18	16	31.0	?
Total	670	100	....	....	61.5	....

The discharge of the river was accurately determined during the past year from the automatic registers of the three gages at Bohio, Gamboa, and Alhajuela, and rating tables based on many hundred careful measurements were compiled. The water heights were taken every two hours to correct for any small changes of level in the torrential stream.

The daily rainfall was observed at Bohio, Gamboa, Alhajuela, and Colon. There is reason to believe that the rainfall at the latter measures quite approximately the precipitation near the sources of the Chagres, as both are situated near the Atlantic coast and not remote from each other.

Considering the limited areas and compact form of the three subbasins, it is not a violent assumption that the average precipitation for the lower subbasin may be estimated by the mean between that measured at Bohio and Gamboa; for the intermediate, by the mean between that measured at Gamboa and Alhajuela; and for the upper, by the mean between that measured at Alhajuela and Colon. Admitting this assumption, the numerical value of the desired ratio between downfall and drainage for the entire basin above Bohio results from the following formula. Similar expressions for the entire basin above Gamboa and for each subbasin are readily deduced. In the formula, Q denotes the discharge at Bohio in cubic metres per second; D, the number of days considered; B, G, A, and C, the rainfall at Bohio, Gamboa, Alhajuela, and Colon in metres; and R, the desired ratio for the days considered.

$$R = \frac{Q \times 3600 \times 24 \times D}{1610^2 \times \left(\frac{250\,(B+G)}{2} + \frac{130\,(G+A)}{2} + \frac{290\,(A+C)}{2}\right)}$$

Although the variable nature of the ratio between downfall and drainage is well known, depending on the character of the storms, the condition of the soil as to moisture and geological formation, the forest growth, and many other local peculiarities, it is not too much to assume that for a single month the variation will be confined to narrow limits in a valley like that of the Chagres. Its numerical value may be found from the above formula by substituting the mean discharge per second at Bohio for Q; the number of days in the month for D; and the respective rainfall for B, G, A, C. The following table exhibits the results obtained from the observations of the past year, conducted with every care to secure accuracy, by the New Panama Canal Company:

Ratio between rainfall and drainage above Bohio.

Month.	Above—		Subbasin.			Former values (7 years) above—	
	Bohio.	Gamboa.	Upper.	Intermediate.	Lower.	Bohio	Gamboa.
1899.							
July	0.44	0.46	0.45	0.50	0.38	0.58	0.65
August	0.84	0.99	1.04	0.80	0.57	0.70	0.64
September	0.61	0.71	0.75	0.62	0.42	0.80	0.63
October	0.65	0.73	0.88	0.59	0.52	0.94	0.86
November	0.81	0.85	0.39	0.72	0.73	0.87	0.77
December	1.39	1.63	1.64	1.51	0.99	1.08	0.99
1900.							
January	1.04	1.47	1.60	0.66	0.48	2.07	2.41
February	7.41	12.00	15.50	*	3.27	1.39	1.97
March	2.63	3.36	3.56	*	1.71	1.15	1.48
April	0.41	0.54	0.90	*	0.21	0.46	0.54
May	0.30	0.36	0.48	*	0.18	0.50	0.58
June	....	....	....	....	....	0.54	0.57

*No outflow.

The figures in the last two columns are added for comparison, although being based only on the discharges actually measured, and on the assumption that the rainfall at Colon measured that in the upper subbasin, where no rain measurements were then made, they are less trustworthy than those of the past year.

Without wishing to attach too much value to the exact figures in this table, it is to be remarked that they generally conform to known conditions in the several months, and accord well with each other. For example, in August and November some rather large freshets occurred, which should and did increase the ratios for those months; but in July, September, and October, when the discharge was less variable, the ratios fell, as they should have done. In leaving the hills and entering the more level district, the ratios become less, as is usually the case.

But the most important and most striking fact developed by these investigations is the exaggerated values of these ratios in the months of little or no rainfall, of which December, 1899, was one. This supplementary volume could only be ground water. For example, in February the rainfall at Bohio was only 0.47 inch; at Gamboa, 0.16; at Alhajuela, 0.04, and at Colon, 0.35. Nevertheless, after two months of previous drought, the average monthly discharge at Bohio was 1,060 cubic feet per second; at Gamboa, 812; and at Alhajuela, the same (812). This water could only have issued from the ground. It is a phenomenon common in the United States. The tributaries of the right bank of the Allegheny River drain a district of glacial drift, while those of the left bank issue from more impermeable soil. In times of severe drought the former often afford a fair discharge while the latter run nearly dry.

That the Chagres belongs to this class of streams is a matter of no small importance for the canal. It gives the explanation of the well-known fact that no fear of a lack of water in the dry season need be entertained with the reserves contemplated by the new company.

CLOUD-BURST AT ERWIN, TENN.

By S. G. WORTH.

The following communication from Mr. S. G. Worth, Superintendent of the United States Fish Commission station at Erwin, Tenn., dated October 13, 1898, relates to an unusual rainfall in that vicinity on August 12, 1898. The Weather Bureau did not have a gage very near this cloud-